Annual Report to NOAA Climate Program Office, Climate and Societal Interactions, Regional Integrated Science and Assessment

Award Title: Alaska Center for Climate Assessment and Policy

Performance Period: June 1, 2013 – May 31, 2014

This performance period covers the third year of Award NA11OAR4310141. In this reporting period the ACCAP office moved physically to be co-located with our administrative home, the International Arctic Research Center (IARC), at the Syun-Ichi Akasofu Building on the University of Alaska Fairbanks (UAF) campus. The new physical location will allow for closer collaboration and coordination between ACCAP and other IARC and UAF researchers, staff, and students.

Team Members:
Principal Investigator: Sarah F. Trainor
Co-Investigators: John Walsh, Philip Loring (until July 1, 2013), Jeremy Mathis, and T. Scott Rupp
Coastal and Living Marine Research Specialist: Philip Loring
Research Associate: Corrine Knapp
Program Manager: Tina Buxbaum
Post-Doctoral Fellows: Peter Bieniek, Nathan Kettle
Graduate Students: Lauren Frisch, Henry Penn

ACCAP Steering Committee:
Ex Officio Members
Dan White, former ACCAP PI and Director, *Institute of Northern Engineering, UAF*;
Molly McCammon, Director, *Alaska Ocean Observing System*;
James Partain, *NOAA Regional Climate Services Director, Alaska Region*;
Aimee Devaris, Acting Director, *NOAA National Weather Service, Alaska Region*;
Amy Holman, Coordinator, *NOAA Regional Collaboration Team, Alaska Region*.
Stephen Gray, Director, *DOI Alaska Climate Science Center*;
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Lawson Brigham, Professor of *Geography & Arctic Policy, UAF*;
Vera Metcalf, Director, *Alaska Eskimo Walrus Commission, Kawerak Inc*.;
Cheryl Rosa, Deputy Director, *U.S. Arctic Research Commission*;
Steve Colt (until 1/1/2014), Professor of Economics, *Institute of Social and Economic Research, University of Alaska Anchorage*
Gunner Knapp (as of 1/1/2014), Director and Professor of Economics, *Institute of Social and Economic Research, University of Alaska Anchorage*.
Greg Balogh, *Arctic Landscape Conservation Cooperative, US Fish and Wildlife Service*

Report Contents

1. NEW AREAS OF FOCUS AND PARTNERSHIPS

In our research, decision-support tool development, and outreach, ACCAP has established new stakeholder partnerships including expanded collaborations with NOAA and non-NOAA federal agencies. We have also expanded our research efforts in climate science, boundary science, and decision-support tool development. Existing strengths remain in coastal and living marine resources, and sea ice and cryosphere hazards. ACCAP partners are highlighted in bold throughout the report.

A. Expanded Federal Office and Agency Collaborations

U.S. Fish and Wildlife Service, Western Alaska Landscape Conservation Cooperative (WALCC). ACCAP is partnering with **WALCC** to identify and synthesize existing research projects in the **WALCC** region related to physical, biological and human dimensions of coastal change. This project documents the research landscape for communities facing change, decision-makers navigating change, researchers pursuing projects, as well as funding agencies trying to prioritize where to allocate resources. The final project report is anticipated in May 2015.

NOAA Ernest F. Hollings (Hollings) Scholar. ACCAP (Walsh), in partnership with the **National Weather Service** (Rick Thoman) will host a NOAA Ernest F. Hollings scholarship intern during the summer of 2014. In March of 2014, the intern, Lauren Zuromski, visited Fairbanks to finalize her project. Using a database of storm and other extreme weather and climate events, she will compile a catalog of impacts and determine the linkages between extreme events and impacts. Lauren will deliver both an ACCAP Alaska Climate webinar and a poster presentation at the Hollings Scholar Symposium in Silver Springs, MD upon the completion of her project in August 2014 (access the project here: https://accap.uaf.edu/node/1102).

Nome Eskimo Community Climate Adaptation Plan. ACCAP partnered with the **Nome Eskimo Community** to submit a grant proposal through the Bureau of Indian Affairs to create a climate adaptation plan for four communities in the Nome region. (Kettle, Walsh, Trainor, Buxbaum)

B. Climate Science

Using Climate Divisions to Construct Anomalies and Trends in Alaska. ACCAP continued partnering with the **NOAA National Weather Service** (Rick Thoman), the **NOAA Alaska Regional Climate Services Director** (James Partain) and the **UAF Department of Atmospheric Sciences** (Peter Bieniek) in a study that uses Alaska climate divisions as the basis for an assessment of Alaska temperature and precipitation trends. The results show that monthly divisional average temperature and precipitation enhances climate information for Alaska, which opens up new potential directions in climate research in the region (see section 2.A for detailed results). A new area of focus for this project includes investigation of extreme events of monthly/daily temperature and precipitation. A journal paper titled "Using Climate Divisions to Analyze Variations and Trends in Alaska Temperature and Precipitation " was published in the *Journal of Climate* in 2014 (Bieniek 2014).

Offshore and Coastal Downscaling. To date, climate downscaling in Alaska has been focused on terrestrial areas. NOAA funding for the downscaling work has been leveraged with funding from the **Alaska Ocean Observing System (AOOS)** through their project known as STAMP (Spatial Tools for Alaskan Marine Planning). This work provides important new data relevant to offshore and coastal locations impacted by variations in surface temperature, winds, and sea ice. This research strengthens existing partnerships with AOOS and the UAF **Scenarios Network for Alaska and Arctic Planning** (SNAP). Additionally, downscaling results were used in the Alaska chapter of the 2014 National Climate Assessment and in the Technical Input Report for the Alaska chapter. The results are also being used in the "Climate Change" chapter of an integrated assessment report for the Bering/Beaufort/Chukchi region in an activity known as "Adaptation Actions for a Changing Arctic," which is coordinated by the Arctic Monitoring and Assessment Program. See section 3.F for discussion of the decision-support tool development associated with this project. Further results are presented in sections 2.A. (Walsh and Trainor)

Dynamical Downscaling for Alaska. In partnership with the DOI **Alaska Climate Science Center and the UAF Department of Atmospheric Sciences (U. Bhatt)**, ACCAP has undertaken a dynamical downscaling project for Alaska. This project is making use of the WRF regional climate model, forced by two global climate models (GFDL and CCSM4) and two different RCP forcing scenarios through 2100. The forcing scenarios are the same ones used in our statistical downscaling. Hindcasts for the post-1979 period are complete, and the 21st-Century simulations are underway.

C. Adaptation and Boundary Science

Evaluation of ACCAP Climate Webinar Series. We evaluated the role of ACCAP's long-term climate webinar series in supporting knowledge to action networks for climate adaptation in Alaska. Semi-structured interviews (n=25) with webinar participants and speakers were used for this evaluation. Our findings highlight how the ACCAP webinar series supports knowledge to action networks in Alaska. Results are currently being

prepared for publication as a book chapter in *Climate in Context* to be released in late 2014 or early 2015 (see sections 2.B and 4 for results and a detailed narrative).

Program Evaluation. In early 2014 ACCAP contracted with the **Goldstream Group Inc**. (Angela Larson) partner in designing and implementing an evaluation of the Historical Sea Ice Atlas for Alaska Waters, the ACCAP Climate and Weather Highlights Tool, and the Alaska Climate Dispatch. We will use the results of this evaluation to measure success in creating useful decision support tools and to inform and refine future development of the tools. The evaluation is ongoing and the bulk of the work will be completed in the upcoming year.

Social Network Analysis of Climate Science, Services and Application in Alaska. This collaborative project with the **DOI Alaska Climate Science Center (AK CSC)** is mapping the landscape of climate science, services, and application in Alaska across a range of sectors and organizations. Thus far, ACCAP scientists have conducted 126 interviews with key individuals involved in climate-related research, services and decision-making in Alaska. Interview transcripts are currently being analyzed to understand (A) the extent to which mutually exclusive categories of producers and consumers of information represents the diversity of actors and organizations involved in climate change decision-making and adaptation (B) how network structure relates to adaptive action. (Trainor, Loring & Kettle)

D. Coastal and Living Marine Resources:

Public Perceptions of Ocean Acidification. In conjunction with the **Ocean Acidification Research Center (OARC)** at UAF and building on the previous work done on an ocean acidification (OA) sensitivity index for Alaska, ACCAP undertook research to better understand public perception in Alaska of OA, ocean health, and related research and policy. ACCAP conducted a mail-based survey to understand self-assessed knowledge and awareness of OA, perceived threats to Alaska fisheries, level of concern, and support for ocean-related research and policy (see section 2.C for results). (Mathis and Frisch)

E. Decision-Support Tool Development

Scenario Planning for Energy and Resource Development on the North Slope, Alaska. ACCAP partnered with the **Geophysical Institute** at UAF and **GeoAdaptive**, a research consultancy with worldwide expertise in the development of complex spatial and participatory scenarios processes on a project commissioned by the **North Slope Science Initiative (NSSI).** NSSI is an intergovernmental effort to increase collaboration at the local, state, and federal levels to address the research, inventory, and monitoring needs as they relate to development activities on the North Slope of Alaska. NSSI partners include The Bureau of Land Management, US Fish and Wildlife Service, National Park Service, National Marine Fisheries Service, Bureau of Ocean Energy Management, AK Department of Natural Resources, AK Department of Fish and Game, Arctic Slope Regional Corporation, North Slope Borough, and the Bureau of Safety and

Environmental Enforcement. ACCAP is providing logistic and outreach support including preparatory open web-based meetings hosted and archived by ACCAP. ACCAP also developed and continues to host a project page within the ACCAP website that contains all pertinent documents and information about this project (project available at https://accap.uaf.edu/Scenario_planning_NSSI).

Offshore and Coastal Downscaling. In conjunction with the offshore and coastal downscaling project described above (section 1.B), ACCAP developed a web-based user interface for access to downscaled data (for an example interface see Figure 1). The distributions of the quantile-mapped variables provide the information for the visualization software. Three "shiny apps" for displaying the daily products have been made publicly available online (http://www.snap.uaf.edu/analysis_tools.php). Three tools enable users to visualize (1) threshold exceedances of temperature and wind, (2) model projections of sea ice, and (3) frequencies of high-wind events in relation to the presence or absence of sea ice. The interface allows a user to select a location, variable of interest (wind, temperature, sea ice concentration), climate model, calendar month or season, historical/future timeframe, and threshold for plots of frequency of occurrence over time. This tool is developed in partnership with the NOAA funded **Alaska Ocean Observing System (AOOS)** and the UAF **Scenarios Network for Alaska and Arctic Planning (SNAP)**. Further details are presented in sections 2.A. (Walsh)

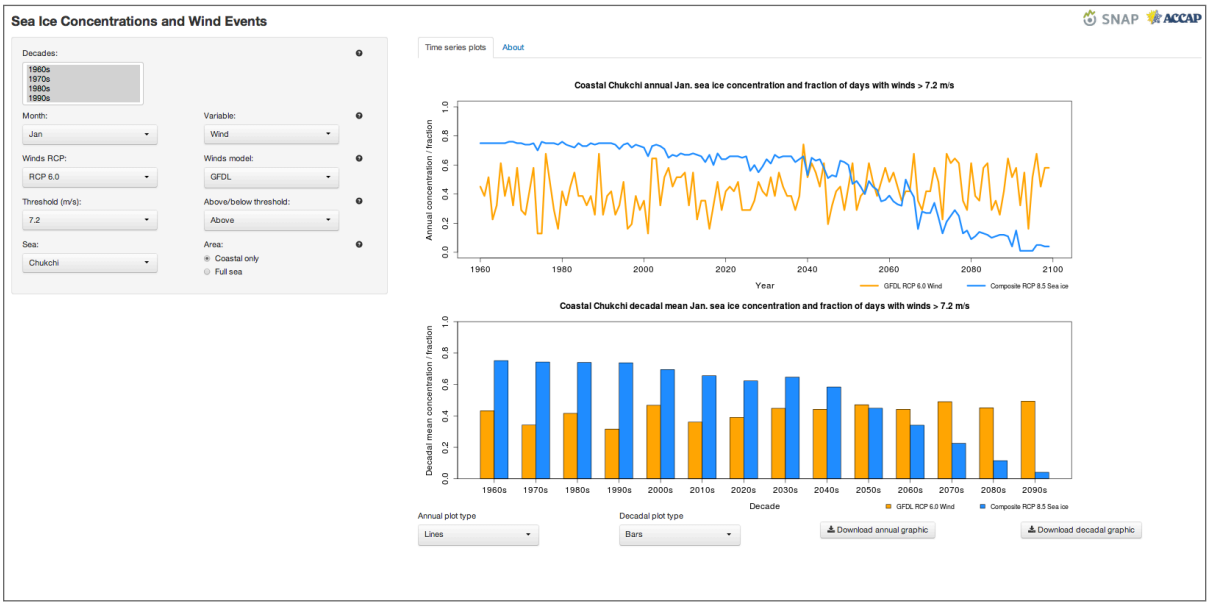

Figure 1. Screenshot of the web-based user interface for the coastal/marine downscaling project showing the projected sea ice and wind conditions for the Chukchi Sea.

Historical Sea Ice Atlas for Alaska Waters. In partnership with **Alaska Ocean Observing System (AOOS),** the **National Weather Service Anchorage Office Sea Ice Desk,** the **National Snow and Ice Data Center (NSDIC), NOAA's Pacific Environmental Marine Laboratory (PMEL), the University of Illinois,** and the UAF **Scenarios Network for Alaska and Arctic Planning (SNAP),** ACCAP completed work

on the Historical Sea Ice Atlas for Alaska Waters, the first gridded, digitized record of historical sea ice concentrations in offshore Alaska. Work was completed on the user interface and exceeds what was describing in the original ACCAP proposal. Stakeholder webinars and surveys were conducted to collect input on the final design of the user-interface and tool capabilities. ACCAP and AOOS are currently exploring the inclusion of sea ice information from Royal Dutch Shell Corporation into the digital atlas. Semi-annual updates will be performed with a small amount of auxiliary funding from AOOS.

See decision support tool section for discussion of the decision-support tool development associated with this project. The Atlas is accessible at http://seaiceatlas.snap.uaf.edu/ (further details are presented in sections 2.D and 3.F). (Walsh and Trainor)

Hydropower Vulnerability Assessment and Best Practices. Many operators of existing hydropower facilities in the state of Alaska manage their water resources with little or no information about water stored in the snowpack or streamflows feeding the reservoirs. They also lack the capacity for making use of seasonal forecasts of temperature and precipitation that may be linked to known modes of climate variability. With leveraged funds from **NOAA National Marine Fisheries Service (NMFS)** this project identifies data and analyses needed for climate vulnerability assessment on hydropower facilities in Alaska. It synthesizes the state of science to-date with an interdisciplinary focus on hydrology, climate variability, and impacts on fish habitat in the Susitna basin. Gap analysis will be conducted to identify critical research needed for a complete vulnerability assessment of climate impacts on hydropower facilities in Alaska. We have reviewed available literature on hydropower and climate change in the North (over 200 articles) and created an endnote database with all reviewed articles. A paper is in preparation for the *Journal of the American Water Resources Society.* (Trainor and ACCAP Affiliate Cherry)

2. RESEARCH FINDINGS

We report our core research findings based on the major areas of focus at ACCAP: climate science, adaptation and boundary science, coastal and living marine resources, coastal vulnerability, sea ice, and wildfire.

A. Climate Science

Offshore and Coastal Downscaling

- Analysis of surface winds and temperature indicates that by the late 21st century, coastal and offshore Alaska will experience major increases in the number of extremely "warm/hot" days (Figure 2) and major decreases in the number of extremely "cool/cold" days relative to present-day thresholds. The changes are especially large in winter and autumn.
- By late century, high-wind events are projected to increase in Alaska's northern coastal waters in summer and autumn; projected trends are weak in other coastal sectors.

- The open water season length, and hence the vulnerability to coastal flooding and erosion, is projected to increase by several months at most coastal locations in western and northern Alaska by late century. This increase results from the retreat of sea ice more than from changes in storminess. (Walsh)

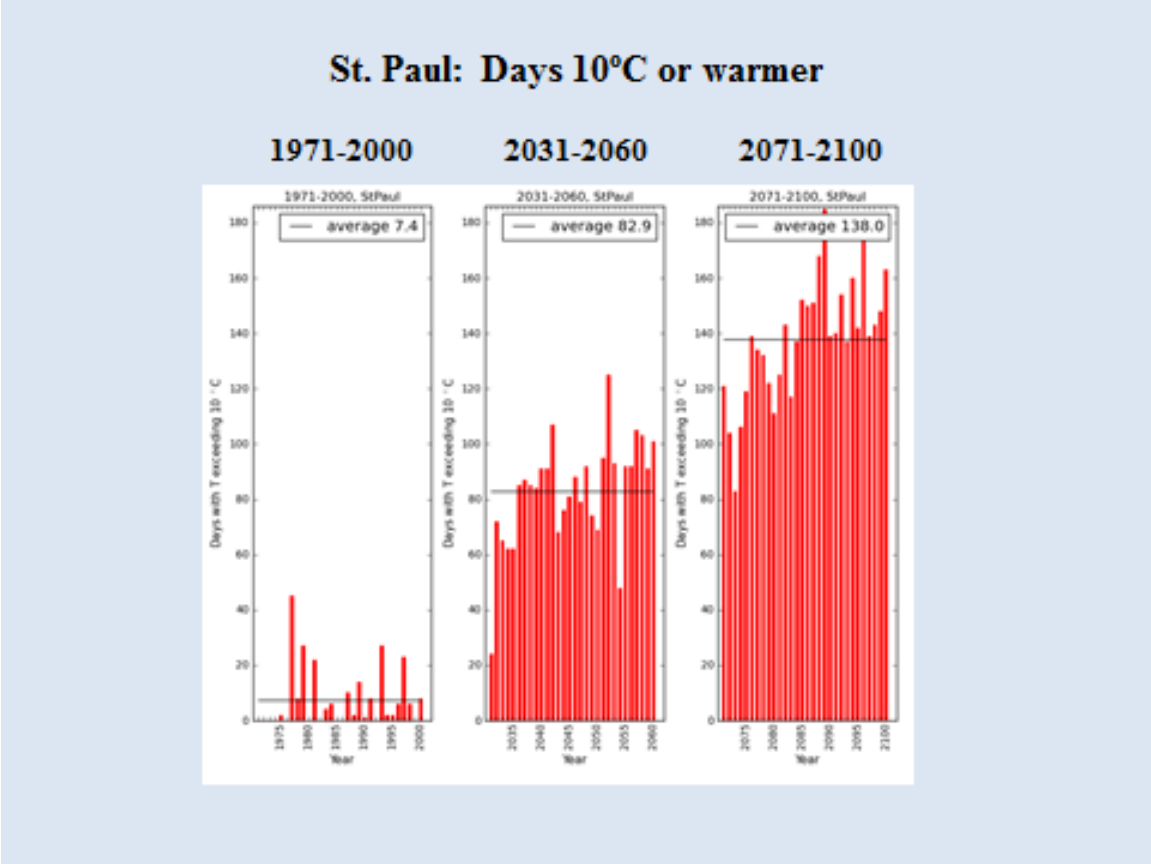

Figure 2. The figure above is an example of the downscaled results obtained from the quantile mapping of daily model output. The figure shows the number of yearly occurrences of days in which the average temperature is 10°C or warmer; the number of such occurrences increases dramatically from a mean of about 5 days per year in the historical (1971-2000) period to more than 100 days per year by the late 21st century. The results are from the CCSM4 model under the RCP 8.5 forcing scenario.

Statistically Downscaled Projections of Snow/Rain Partitioning for Alaska

ACCAP in collaboration with **SNAP** and the **DOI Alaska Climate Science Center,** participated in the construction and evaluation of 771 m-resolution gridded historical and statistically downscaled projections of snow/rain partitioning for the state of Alaska at decadal temporal resolution.

- The method developed uses observational data to describe the relationship between average monthly temperature and the fraction of wet days in that month receiving snow, also known as the snow-day fraction.

- Regionally and seasonally specific equations were developed to accommodate variability in synoptic scale climatology of rain and snow events. These equations were then applied to gridded decadal temperature data and projections.
- The gridded products provide a reasonable characterization of snow-day fraction throughout the state. However, there are local deviations from the regional relationships, particularly in the topographically complex areas bordering the Gulf of Alaska and Cook Inlet.

When applied to questions about changing precipitation regimes in northern, western and southeastern Alaska, these data demonstrate the potential for marked changes from snow-dominated to mixed precipitation regimes and also exhibit a wide range of potential future conditions.

Alaska Climate Divisions

- Long-term (1920-2012) monthly divisional anomalies of temperature display similar decadal variability to the Pacific Decadal Oscillation in all 13 Alaska climate divisions.
- Short-term trends are variable and linked to the decadal variability of temperature, however there is a long-term trend of increasing temperature superimposed on the decadal variability.
- Precipitation variability and trends are much less coherent than those for temperature.

B. Sea Ice

Historical Sea Ice Atlas for Alaska Waters

Scientific results from an analysis of the Sea Ice Atlas data include the following:

- The recent (post 2007) period is unique in its retreat of summer sea ice in the Alaska seas. No month since 1850 has had as little sea ice in Alaska waters as did September 2012.
- The open water season length has increased by 1 to 2 months since 1950 in most coastal seas of Alaska; the increase is even greater at some locations in the Chukchi and Beaufort Seas.
- The trend of Alaska sea ice loss over the past 100-150 years has been much larger in summer than in winter. The corollary is that Bering Sea ice cover has decreased much more slowly than sea ice in the Chukchi and Beaufort Seas.

C. Adaptation and Boundary Science

Meta-analysis of Alaska Research Needs

We reviewed and coded sixty-three stakeholder-generated documents that address climate change research needs in Alaska in order to synthesize common research needs and determine gaps in needs assessment.

- Documents in the needs assessment review nearly unanimously expressed that science, as it is currently practiced, is inadequate to meet the challenges of climate

change. They call for processes that are more transparent, collaborative, and accessible. (Knapp and Trainor 2013)

- We find that research needs related to infrastructure, economics, hazards and safety, and terrestrial ecosystem impacts are most frequently mentioned.
- The review identifies a current focus on broad-scale expert assessments, and a gap in local-scale and participatory approaches. Needs assessments are often conducted at large spatial scales and rely heavily on expert knowledge. There is a need for more local scale, collaborative needs assessments.
- The majority of identified information needs cross traditional disciplines and require interdisciplinary approaches.
- Finally, this research suggests a new model for science communication that underscores the importance of iterative dialogue between scientists, stakeholders and translators in order to better link scientific inquiry to practice. (Knapp and Trainor, in preparation for *Polar Geography*)

Evaluation of ACCAP Climate Webinar Series

We evaluated the role of ACCAP's long-term webinar series in supporting knowledge to action networks for climate adaptation in Alaska. Our findings highlight how the ACCAP webinar series supports knowledge to action networks in Alaska by:

- Providing opportunities for participants to learn about climate science, impacts, and decision-support.
- Providing a venue for participants to connect with new constituents, learn about their priorities, concerns, and needs, and expand their networking capacity.
- Promoting cross-scale linking functions by creating a platform for scientists to engage with managers and decision-makers with experience and jurisdiction on the local, state, national and international levels (see Figure 3).

Please see section 4 for for further details and findings on the webinar evaluation.

Examples of Interactions in the ACCAP Climate Webinar Series

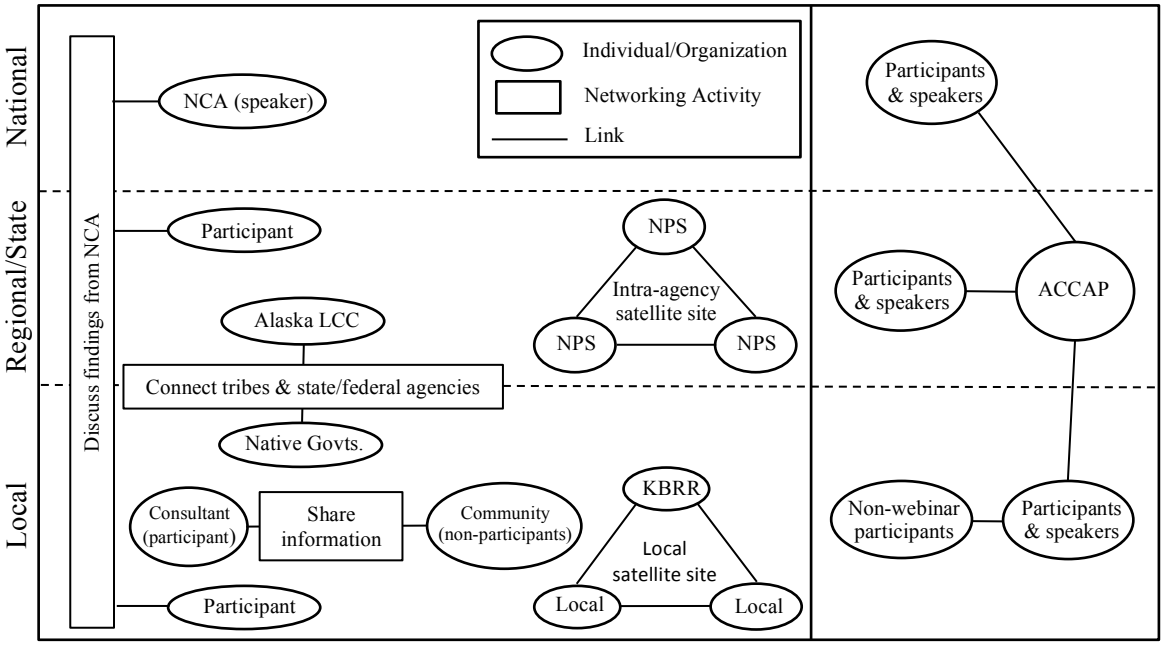

Figure 3. Schematic representing vertical and horizontal interplay that occurs in conjunction with ACCAP Climate Webinars. The vertical axis represents the scale at which information application or network interactions take place. The horizontal axis represents interactions within each level (i.e. local, regional/state, and national). The left side of the diagram illustrates specific examples of interactions and activities that occur, in part, as a result of the webinar series. The right side of the diagram shows a more general schema of ACCAP's networking interactions within the webinar series.

D. Coastal and Living Marine Resources:

Public Perceptions of Ocean Acidification

Ocean acidification (OA) has important implications in Alaska because of potential impacts on the fishing industry, including commercial, sport, and subsistence fisheries. A random public survey was distributed to assess public perception of ocean threats, the basic level of understanding of ocean and climate related issues, and support for ocean-related research and policy. The major findings of the research are:

- Alaskan residents believe they have a limited knowledge and awareness of OA.
- Participants with a higher level of self-assessed understanding of OA associate OA with human activity, but do not associate OA with natural variability.
- Among factors assessed, ocean acidification is the second greatest perceived threat to Alaska fisheries, only behind overfishing.
- Concern for OA increases from the near term (present to 10 years from now) to the future (50-100 years)

In conjunction with the OA Sensitivity Index (ACCAP project completed in 2012) we are using the results of this work to determine gaps in public understanding of OA and identify where and how to focus outreach and education initiatives. Collectively, this

information will direct ACCAP and the **Ocean Acidification Research Center** on how to best communicate with communities and commercial fishing interests to prepare for future ocean changes. A paper summarizing these findings is in progress (Frisch, Mathis, Kettle, and Trainor).

E. Wildfire

Modeling the Effects of Fire Severity and Climate Warming

The integration of the fire severity model into an ecosystem process-based model allowed us to document the relative importance and interactions among local topography, fire regime and climate warming on active layer and soil carbon dynamics.

- Lowlands were more resistant to severe fires and climate warming, showing smaller increases in active layer thickness and soil carbon loss compared to drier flat uplands and slopes.
- In simulations that included the effects of both warming and fire at the regional scale, fire was primarily responsible for a reduction in organic layer thickness by 2100 that led to an increase in active layer thickness by 2100.
- The combination of warming and fire led to a simulated cumulative loss of 9.6 kgC m−2 on average by 2100.

Our analysis suggests that ecosystem carbon storage in boreal forests in interior Alaska is particularly vulnerable, primarily due to the combustion of organic layer thickness in fire and the related increase in active layer thickness that exposes previously protected permafrost soil carbon to decomposition. (Rupp)

3. KEY OUTREACH ACTIVITIES

During this reporting period, ACCAP investigators presented their research, participated in panel discussions, hosted workshops, and chaired sessions in a variety of venues, including within Alaska and on a national level:

- **Alaska**: Alaska Weather Symposium, Alaska Forum on the Environment, American Fisheries Society - Alaska Chapter, Alaska Marine Science Symposium, Western Alaska Interdisciplinary Science Conference, Tanana Valley State Fair and during a reception for the Alaska Arctic Policy Commission.
- **National**: American Meteorological Society Annual Meeting, American Geophysical Union Fall Meeting

In addition USA Today interviewed ACCAP PI Sarah Trainor for a story on permafrost and climate change in Alaska (http://www.usatoday.com/story/news/nation/2013/10/08/alaska-sinks--climate-change-thaws-permafrost/2794255/).

We report specific outreach activities based on the major areas of focus at ACCAP: federal agency collaboration, climate science, adaptation and boundary science, coastal and living marine resources, coastal vulnerability, sea ice, and wildfire.

A. Federal Office and Agency Collaborations

Contributions to the National Climate Assessment. ACCAP investigators were Convening Lead Authors (CLA) on three chapters of the 2013 National Climate Assessment. J. Walsh is CLA for the Climate Science chapter and S. Trainor is CLA for the Alaska and Arctic chapter. In this reporting period, draft chapters were revised based on NCADAC feedback. The public comment period ended in April 2014, and CLAs responded to public comments. The National Climate Assessment was released May 5, 2014 (see section 5 for full citation).

B. Climate Science

Offshore and Coastal Downscaling

- The quantile-mapping methodology and outputs were presented at a workshop of the Aleutian and Bering Sea Islands LCC (Anchorage, January 2014) for use in an ongoing vulnerability assessment for that region (Walsh).
- Our downscaling methods and highlights of results were also presented at the Alaska Marine Science Symposium in January 2014 (Walsh).
- A presentation on downscaling for the Alaskan coastal and marine region was made at the annual meeting of the AOOS Steering Group (Walsh).

Using Climate Divisions to Construct Anomalies and Trends in Alaska

- AGU Fall Meeting 2013 (oral presentation, A42A-05): Atmospheric circulation patterns associated with extreme events in Alaska (Bieniek).
- Presentation to the Calista Science Council elders on the use of climate divisions in southwest Alaska (Bethel, AK, Feb 4, 2014) (Bieniek).

C. Adaptation and Boundary Science

- Supporting local climate adaptation planning. Alaska Rural Water and Sanitation Working Group (US Arctic Research Commission-coordinated working group) Fairbanks, AK; 18 March 2014 (Kettle).
- Climate webinars: a platform for knowledge to action networks in Alaska. Association of American Geographers Annual Conference. Tampa, FL: 8-12 April 2014 (Kettle).

Meta-analysis of Needs Assessments

- Oral presentation "Documenting Alaskan adaptation needs" at Alaska Forum for the Environment in February 2014, in Anchorage, Alaska (Knapp).

D. Coastal and Living Marine Resources

- "Plenary: Resilience, Climate Change, and Fisheries," 40th Annual Meeting of the American Fisheries Society, Alaska Chapter. 9 October 2013, Fairbanks, AK (Loring).

E. Wildfire

- Challenges in Modeling Disturbance Regimes and Their Impacts in Arctic and Boreal Ecosystems. AGU 2013 Plenary Talk. A.D. McGuire, **T.S. Rupp**, W. Kurz.
- Modeling the effect of wildfire on permafrost vulnerability, vegetation composition and carbon balance in Alaskan boreal forest. AGU 2013. H. Genet, A.D. McGuire, J. Johnstone, A. Breen, E.S. Euskirchen, M. Mack, A. Melvin, **T.S. Rupp**, E. Schuur, F. Yuan

F. Decision-Support Tools

Historical Sea Ice Atlas for Alaska Waters

In partnership with **AOOS,** the **National Weather Service Anchorage Office Sea Ice Desk,** the **National Snow and Ice Data Center (NSIDC), NOAA's Pacific Environmental Marine Laboratory (PMEL), the University of Illinois,** and **SNAP,** ACCAP completed work on the Historical Sea Ice Atlas for Alaska Waters, (see sections 1.E and 2.B for further details). Work was completed on the user interface (Figure 4) and a public webinar was conducted in February 2014 with almost 100 participants. The webinar resulted in newspaper interviews leading to stories in the Fairbanks Daily News-Miner and Alaska Dispatch (stories available on the Atlas project page - https://accap.uaf.edu/project/digital-sea-ice-atlas-alaska-waters). These stories were then picked up by multiple news agencies. The Atlas was also presented as a poster presentation at the Alaska Marine Science Symposium, Anchorage, AK, in January 2014 and as a presentation at the 7th Western Alaska Interdisciplinary Science Conference (Kotzebue, Alaska, April 2014). The database in now showcased on the NOAA National Ocean Service website (http://oceanservice.noaa.gov/news/mar14/alaska-sea-ice.html). (Walsh and Trainor).

Figure 4. Shown above is a screen shot from the home page of the user interface for the Historical Sea Ice Atlas (http://seaiceatlas.snap.uaf.edu/)

G. General Stakeholder Outreach

Web Presence. The ACCAP website underwent a redesign, with launch of the new site on June 18, 2013. The website development team completed a requirements analysis to determine audience and stakeholder needs of the current website, and used this information to develop and code the new site. Efforts were completed to update and re-vamp the **ACCAP Climate and Weather Highlights Tool** in collaboration with Rick Thoman, the Climate Science and Services Manager for the **National Weather Service Alaska Region**. The revamped Climate and Weather highlights tool was launched on the ACCAP website July 24, 2013 and continues to be updated and populated with new information in near real time (Access the tool at: https://accap.uaf.edu/?q=tools/climate_highlights#date/2014-05).

Social Media. This year, ACCAP has seen an increase in social media influence, with 446 fans on Facebook (261 last year) and 178 followers on Twitter (65 last year). ACCAP's Facebook presence averaged a reach of 132 people per day during this reporting period with a maximum daily reach of 932 people during the launch of the new website in June 2013.

Newsletters. Published quarterly since 2010 and written for a non-technical audience, the *Alaska Climate Dispatch* (see sections 5 and 6) features seasonal weather and climate summaries as well as Alaska weather, wildfire, and sea ice outlooks. ACCAP published

the inaugural issue of *Changing Ice* in December 2012 and the second edition in September 2013 (see section 5 and 6). This is a semiannual newsletter written for a non-technical audience, highlighting projects and discoveries led by Alaskan scientists engaged in cryosphere research.

Monthly Webinars. ACCAP continues to host monthly Alaska Climate Webinar Series, accessible to stakeholders directly and through a network of hub-viewing locations. Since 2007, ACCAP has hosted statewide climate webinars designed to promote dialogue between scientists and people who need information related to climate change in Alaska to make well-informed decisions (more details available in section 4).

More than 1059 people participated in ACCAP webinars during this reporting period with a maximum single event participation of 183 participants for the November 2013 Ocean Acidification webinar presented by Jeremy Mathis. ACCAP webinars draw a diverse audience, including representatives from the media, federal and state agencies, industry, and tribal groups, and are increasing used by federal collaborators as a cost-effective way to reach Alaska stakeholders. In addition to noted scientists from **UAF** and other universities across the country and Canada (**University of Alberta**), and regionally based partners, ACCAP webinars this year featured scientists from federal partners including **NOAA's Climate.Gov** team and the **USFS Pacific Northwest Research Station (PNW)** and private enterprise including **Atkins Engineering**, and **Alaska Veterinary Pathology Services (AVPS).**

H. Student and Post-Doc Matriculation and Recruitment

- Ph.D. student Eunkyoung Hong published her findings about permafrost settlement caused by climate warming in Alaska and estimating damage costs to public infrastructure in *The Arctic* in March 2014.
- Post-doctoral fellow, Nathan Kettle, continues to spearhead the boundary science, social network analysis, and webinar evaluation (see section 1.C, 2.C, 3.C and 4).
- Post-doctoral fellow, Peter Bieniek, continues to conduct the climate science project, *Using Climate Divisions to Construct Anomalies and Trends in Alaska* (see sections 1.B and 2.A). His most recent publication appeared in April 2014 in the *Journal of Climate.*
- Master student Lauren Frisch completed her survey of perceptions of ocean acidification in Alaska (sections 1.D and 2.D), successfully defended her masters work at Bard College in New York State. She is working with ACCAP post-doctoral fellow Nathan Kettle to publish her findings and continues to work in the UAF Ocean Acidification Research Center.

4. NARRATIVE

ACCAP explored the role of a long-term webinar series (initiated in June 2007) in supporting knowledge to action networks for climate adaptation in Alaska. The analysis is based on the examination of ACCAP's ongoing monthly Climate Webinar Series. Two datasets were examined for this analysis: a webinar participant database and semi-

structured interviews (n=25) with webinar participants and speakers. Our findings highlight several ways that the ACCAP webinar series supports knowledge to action networks in Alaska.

ACCAP has hosted 68 climate-related webinars between June 2007 and June 2013 and another 12 webinars since this analysis was completed. The webinar format in which participants can join remotely as individuals or as part of hub satellite sites located around the state promotes both virtual and face-to-face interactions. ACCAP publicizes the webinars via the ACCAP list serve and social media (Facebook and Twitter), and leverages partnerships with organizations such as the Arctic Institute, the Arctic Research Consortium of the US (ARCUS), the National Oceanic and Atmospheric Administration (NOAA), the University of Alaska Fairbanks (UAF) media relations and various UAF departments to extend publicity outreach. Webinars occur on a monthly basis and typically last one hour including the presentation and a question-and-answer session. A wide range of topics are covered, reflecting the diversity of climate-related challenges and opportunities across Alaska. Webinars showcase cutting-edge scientific research results, innovative climate-related decision support tools, and national scale reports and initiatives. Topics are selected to create a balance among marine/coastal, terrestrial, and human dimensions issues, and cover themes related to adaptation and planning, climate variability and change, and climate impacts. Speakers are invited from a variety of universities nation-wide and from organizations and agencies across the state and the country. The target audience, representing ACCAP's major stakeholder groups, are diverse and varied, including communities, tribal governments, municipal, state, and federal agencies, non-profit and non-governmental organizations (NGOs), the news media, scientists and engineers, planners and managers, and industry statewide in Alaska.

Participation in the ACCAP climate webinar series is characterized by an expanding, fluid, and diverse network of participants. Participation per webinar has nearly tripled since the inception of the webinar series in June 2007. The mean attendance for 2013 is roughly 80 participants per event. In total, over 5000 individuals (number not corrected for repeating participants) have attended ACCAP webinars between June 2007 and June 2014.

We found that webinars provide opportunities for participants to learn about climate science, impacts, and decision support, and participants report that they use this information in their education and outreach, and planning. Webinars also provide a venue for participants and participant organizations to connect with new constituents, learn about their priorities, concerns, and needs, and expand their networking capacity. Significantly, webinars promote cross-scale linking functions by creating a platform for participants to engage with others who have experience and jurisdiction on a local, state, national and/or international level.

5. HIGHLIGHTED PUBLICATIONS, WHITE PAPERS, & REPORTS

Journal Articles

- **Bieniek, P.A., J.E. Walsh**, R.L. Thoman, U.S. Bhatt, (2014): Using Climate Divisions to Analyze Variations and Trends in Alaska Temperature and Precipitation. *J. Climate*, **27**, 2800–2818.
- **Knapp, C., S.F. Trainor,** Adapting science to a warming world. Global Environmental Change. Knapp, C., Trainor, S.F. (2013) *Global Environmental Change*, Volume 23, Issue 5, , Pages 1296–1306
- Rogers, T. S., **J. E. Walsh, T. S. Rupp**. L. W. Brigham and M. Sfraga, (2013): Future Arctic marine access: Analysis and evaluation of observations, models, and projections of sea ice. *The Cryosphere, 7,* 321-332.
- **Walsh, J. E**., (2013): Melting ice: What is happening to Arctic sea ice and what does it mean for us? *Oceanography, 26*, 171-181.
- Bennett, K. E., and **J. E. Walsh**, (2013): Spatial and temporal changes in indices of extreme precipitation for Alaska. *International Journal of Climatology,* in press.
- McAfee, S. A., **J.E. Walsh and T. S. Rupp**, (2014): Statistically downscaled projections of snow/rain partitioning for Alaska. *Hydrological Processes*, 28, 3930-3946.
- Cochran, P., O. Huntington, C. Pungowiyi, S. Tom, F.S. Chapin III, H. P. Huntington, N. G. Maynard, **S. F. Trainor**. (2013). "Indigenous Frameworks and Observations of Climate Change in Alaska." *Climatic Change.* 120:557-567
- **Hong, Eunkyoung**; R. Perkins; **S.F.Trainor,** (2014). Thaw Settlement Hazard of Permafrost Related to Climate Warming in Alaska. *ARCTIC*, v. 67, n. 1, p. 93–103,.

Book Chapters

- Chapin, F. S., III, **S. F. Trainor**, P. Cochran, H. Huntington, C. Markon, M. McCammon, A. D. McGuire and M. Serreze, (2014): Alaska and the Arctic. Chapter 22 of the Third U.S. National Climate Assessment. U.S. Global Change Research Program, Washington, D.C.
- **Trainor S. F., N. Kettle, J.B. Gamble** (In Review). Not Another Webinar! Regional Webinars as a Platform for Climate Knowledge to Action Networking in Alaska. In Climate in Context, eds. A. Parris and G. Garffin. Wiley & Sons.
- **Trainor, S.F.** (2013). Deeper Sense of Place for Indigenous and Western Science Partners in Climate Change Assessment and Adaptation in Alaska. In A Deeper Sense of Place: Stories and Journeys of Indigenous-Academic Collaboration, eds. J. Johnson & S. Larsen. Corvallis: Oregon State University Press.
- **Walsh, J. E**., and W. L. Chapman, (2014): Variability of sea ice over decadal and longer timescales. *Climate Change: Multidecadal and Beyond.* National Taiwan University, Taipei (Peer-reviewed volume, in press).
- **Walsh, J. E**., D. J. Wuebbles, K. Hayhoe, J. Kossin, K. E. Kunkel, G. Stephens, P. Thorne, R. Vose, M. Wehner and J. Willis, (2014): Our Changing Climate.

Chapter 2 of the Third U.S. National Climate Assessment. U.S. Global Change Research Program, Washington, D.C.

Technical Report:

- **Trainor, S.F.**, Contributing Author. (2013). Provisioning and Cultural Services. Huntington, H.P. Lead Author; *The Arctic Biodiversity Assessment*. The Arctic Council.

White Papers & Newsletters

- **Walsh, J.E., S.F. Trainor, and A. York** (eds). Alaska Climate Dispatch Quarterly Newsletter. (https://accap.uaf.edu/library/dispatches)
- Gusmeroli, A, **S.F. Trainor,** G. Wolken, H. Eicken, M. Truffer, G. Grosse. 2013. Changing Ice: A Newsletter of Cryosphere Research in Alaska. (https://accap.uaf.edu/sites/default/files/Changing_Ice_September_2013_1.pdf)

6. ATTACHMENTS/APPENDICES

(All attachments have been optimized and placed in one PDF for digital delivery. Please request higher resolution files for print.)

1. Alaska Climate Dispatch (June 2013, September 2013, December 2013, March 2014)

2. Changing Ice Cryosphere Hazards Newsletter (September 2013)

3. Peer – reviewed journal publication listed above.